

CLAIMS

1. A sealing element comprising a hollow body (26) of metallic material and a first male sealing member (21a) formed at a first end of the body (26), said first male sealing member (21a) having an external spherical contact surface (23a) designed for mating with a corresponding internal conical contact surface of a first female sealing member so as to form a fluid-tight seal between the first male sealing member and the first female sealing member when their contact surfaces are pressed against each other, characterized in:
 - 5 - that the sealing element (20) comprises a second male sealing member (21b) formed at a second end of the body (26) opposite said first end, said second male sealing member (21b) having an external spherical contact surface (23b) designed for mating with a corresponding internal conical contact surface of a second female sealing member so as to form a fluid-tight seal between the second male sealing member and the second female sealing member when their contact surfaces are pressed against each other, and
 - 10 - that an internal bore (22) extends through the body (26) and through the first and second male sealing members (21a, 21b), the spherical contact surface (23a, 23b) of the respective male sealing member (21a, 21b) surrounding said internal bore (22).
2. A sealing element according to claim 1, characterized in that the first male sealing member (21a) is coaxial with the second male sealing member (21b).
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3. A sealing element according to claim 1 or 2, characterized in that that the body (26) is provided with an intermediate member (24), which forms a continuous part together with the first and second male sealing members (21a, 21b) and which is mechanically compressible so as to be capable to store elastic energy when the body (26) is subjected to axial compression, and that the internal bore (22) extends through said intermediate member (24).
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4. A sealing element according to claim 3, characterized in that the intermediate member (24) is expandable by an internal fluid pressure in the body (26) so as to urge the respective male sealing member (21a, 21b) outwards in the axial direction of the body (26)
5 against the corresponding female sealing member when the sealing element is fitted between said female sealing members, thereby increasing the sealing contact pressure between the respective male sealing member and the corresponding female sealing member.
- 10 5. A sealing element according to claim 4, characterized in that the intermediate member (24) has an internal cross-sectional area which is larger than the external cross-sectional area of the respective male sealing member (21a, 21b) as seen at the point (P) of the male sealing member where the male sealing member is designed to engage with the corresponding female sealing member.
- 15 6. A sealing element according to any one of claims 3-5, characterized in that the intermediate member (24) is essentially shaped as a single or multiple wave bellows.
- 20 7. A coupling device, characterized in
 - that it comprises a male coupling part (20) in the form of a sealing element according to any of claims 1-6, a first female coupling part (10) provided with a first female sealing member (11) and having an internal bore (12) extending through the coupling part (10) and its female sealing member (11), and a second female coupling part (30) provided with a second female sealing member (31),
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 - that the first female sealing member (11) has an internal conical contact surface (13) of metallic material for engagement with the spherical contact surface (23a) of the first male sealing member, the spherical contact surface (23a) of the first male sealing member and the corresponding conical contact surface (13) of the first female sealing member being designed to form a fluid-tight seal
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 - that the first female sealing member (11) has an internal conical contact surface (13) of metallic material for engagement with the spherical contact surface (23a) of the first male sealing member, the spherical contact surface (23a) of the first male sealing member and the corresponding conical contact surface (13) of the first female sealing member being designed to form a fluid-tight seal
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part (10) when said contact surfaces (23a, 13) are pressed against each other, and

5 - that the second female sealing member (31) is provided with an internal conical contact surface (33) of metallic material for engagement with the spherical contact surface (23b) of the second male sealing member (21b), the spherical contact surface (23b) of the second male sealing member (21b) and the corresponding conical contact surface (33) of the second female sealing member (31) being designed to form a fluid-tight seal between the male coupling part (20) and the second female coupling part (30) when 10 said contact surfaces (23b, 33) are pressed against each other.

8. A coupling device according to claim 7, characterized in that the second female coupling part (30) has an internal bore (32) extending through the coupling part (30) and its female sealing member (31).

15 9. A coupling device according to claim 7, characterized in that the second female coupling part (30) is designed as a stop member adapted to close the internal bore (22) of the male coupling part 20 (20) when the male coupling part is clamped between the first and second female coupling parts (10, 30).

25 10. A coupling device according to any one of claims 7-9, characterized in

- that at least one of the first and second female coupling parts (10, 30) is provided with a valve (40), which comprises a valve body (41) displaceably arranged inside the internal bore (12, 32) of the female coupling part and a spring member (42) acting on the valve body, the valve body being displaceable against the action of the spring member (42) from a first position, in which the valve is closed and prevents fluid flow through the internal bore (12, 32) of the female coupling part, to a second position, in which the valve is open and allows fluid flow through the internal bore of 30 the female coupling part, and

35 - that the male coupling part (20) is provided with an actuation member (25) for displacing the valve body (41) from said first posi-

tion to said second position immediately before the female sealing member (11, 31) of the female coupling part (10, 30) is brought into engagement with the corresponding male sealing member (21a, 21b) of the male coupling part (20).

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11. A coupling device according to claim 10, characterized in

- that the valve (40) comprises a housing (43) which is immovably fixed inside the internal bore (12, 32) of the female coupling part (10, 30), said housing being provided with a cavity (44) accommodating the spring member (42) and a part of the valve body (41), and

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- that said cavity (44) is in fluid communication with an orifice (45) at the end of the valve facing the free end of the female sealing member (11, 31) of the female coupling part (10, 30) so as to allow the cavity to be in fluid communication with the surroundings via said orifice (45) when the female coupling part (10, 30) is out of engagement with the male coupling part (20).

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12. A coupling device according to claim 11, characterized in that

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the actuation member (25) is adapted to restrict the flow through the orifice (45) when the female sealing member (11, 31) is in engagement with the corresponding male sealing member (21a, 21b).

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13. A coupling device according to claim 11 or 12, characterized in

that the cavity (44) is in fluid communication with the orifice (45) via a channel (46) extending through the valve body (41).

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14. A coupling device according to claim 13, characterized in that

said channel (46) extends axially through the valve body (41).

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15. A coupling device according to claim 13 or 14, characterized in

that the actuation member (25) is adapted to engage with the valve body (41) so as to cover the orifice (45) and thereby restrict the flow through the orifice when the female sealing member (11, 31) is in engagement with the corresponding male sealing member (21a, 21b).

16. A coupling device according to any one of claims 10-15, characterized in

- that the valve (40) is provided with a ring-shaped seal element (47) arranged in an annular groove (48), which groove is provided in the inner wall (49) of the internal bore (12, 32) of the female coupling part, and
- 5 - that an external surface (50) of the valve body is adapted to engage with the ring-shaped seal element (47) so as to form a fluid-tight seal between the inner wall (49) of the internal bore (12, 32) and the valve body (41) when the valve body is in said first position.

10 17. A coupling device according to any one of claims 10-16, characterized in

- 15 - that the valve body (41) comprises a first body part (41a) and a second body part (41b), said first body part (41a) being located in front of the second body part (41b) as seen in a direction along the associated internal bore (12, 32) towards the associated female sealing member (11, 31),
- 20 - that a first flow path section (51a) is provided radially outwardly of the first body part (41a) between the valve housing (43) and the inner wall (49) of the internal bore (12, 32), and a second flow path section (51b) is provided between the second body part (41b) and said inner wall (49), said first and second flow path sections (51a, 51b) extending essentially in the axial direction of the internal bore (12, 32) on mutually different levels as seen in the radial direction of the internal bore,
- 25 - that the first flow path section (51a) is connected to the second flow path section (51b) via an intermediate flow path section (51c) extending obliquely in relation to the first and second flow path sections (51a, 51b), and
- 30 - that the first body part (41a) is adapted to block the intermediate flow path section (51c) when the valve body (41) is displaced from said second position to said first position.

18. A coupling device according to claim 17 in combination with
claim 16, characterized in that the second body part (41b) has a
smaller cross-sectional area than the first body part (41a), that the
second body part (41b) is surrounded by the ring-shaped seal
5 element (47) and out of engagement therewith when the valve
body is in said second position, that an external surface of the first
body part (41a) is adapted to be brought into engagement with the
ring-shaped seal element (47) so as to form a fluid-tight seal be-
tween the inner wall (49) of the internal bore (12, 32) and the
10 valve body (41) when the valve body is displaced from said sec-
ond position to said first position, and that the end of the first body
part (41a) facing the second body part (41b) only has blunt edges
so that the ring-shaped seal element (47) will meet no sharp edge
when the valve body (41) is displaced between said positions.
- 15 19. A coupling device according to claim 17 or 18, characterized in
that the intermediate flow path section (51c) is defined partly by
an external surface (50c) of the valve body (41) which extends
obliquely, as seen in the axial direction of the valve body (41), be-
20 tween the first body part (41a) and the second body part (41b).
- 25 20. A coupling device according to any one of claims 7-19, charac-
terized in that the coupling device (100) constitutes a hydraulic
subsea coupling.
21. A valve device, characterized in
- that it comprises a first valve part (110) provided with a first fe-
male sealing member (111) and having an internal bore (112) ex-
tending through the valve part (110) and its female sealing member
30 (111), a second valve part (130) provided with a second female
sealing member (131), and a sealing element (20) according to any
of claims 1-6 interposed between the first female sealing member
(111) and the second female sealing member (131),
- that the first female sealing member (111) has an internal conical
35 contact surface (113) of metallic material for engagement with the
spherical contact surface (23a) of the first male sealing member
(21a), the spherical contact surface (23a) of the first male sealing

- member and the corresponding conical contact surface (113) of the first female sealing member being designed to form a fluid-tight seal between the sealing element (20) and the first valve part (110) when said contact surfaces (23a, 113) are pressed against each other, and
- that the second female sealing member (131) is provided with an internal conical contact surface (133) of metallic material for engagement with the spherical contact surface (23b) of the second male sealing member (21b), the spherical contact surface (23b) of the second male sealing member and the corresponding conical contact surface (133) of the second female sealing member being designed to form a fluid-tight seal between the sealing element (20) and the second valve part (130) when said contact surfaces (23b, 133) are pressed against each other.
22. A valve device according to claim 21, characterized in that the first valve part (110) and the second valve part (130) are displaceable in relation to each other in the axial direction of the body (26) of the sealing element (20) between a first position, in which the contact surface (23a, 23b) of both male sealing members (21a, 21b) is pressed against its corresponding contact surface (113, 133) of the female sealing members (111, 131), and a second position, in which the contact surface (23a, 23b) of at least one of the male sealing members (21a, 21b) is out of engagement with its corresponding contact surface (113, 133) of the female sealing members (111, 131).
23. A valve device according to claim 22, characterized in that the contact surface (23b) of the second male sealing member (21b) is out of engagement with the corresponding contact surface (133) of the second female sealing member (131), whereas the contact surface (23a) of the first male sealing member (21a) is in engagement with the corresponding contact surface (113) of the first female sealing member (111), when the first and second valve parts (110, 130) are in said second position.

24. A valve device according to claim 22 or 23, characterized in that the valve device (102) is provided with a flow channel (103), which is connected to the internal bore (112) of the first valve part (110) via the space between the first female sealing member (111) and the second female sealing member (131), and that said flow channel (103) is in fluid communication with the internal bore (112) of the first valve part when the first and second valve parts (110, 130) are in said first position, whereas said flow channel (103) is not in fluid communication with the internal bore (112) of the first valve part when the first and second valve parts (110, 130) are in said second position.
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25. A valve device according to any of claims 21-24, characterized in that the valve device (102) constitutes a subsea valve.